

Antibacterial activity of medicinal plants of northern Peru – Part II

Actividad antibacteriana de plantas medicinales de Perú – Parte II

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Abstract

Bacterial infections and inflammation are among the ailments treated by traditional healers. The World Health Organization has expressed high interest in Traditional Medicine, and it is important to demonstrate scientifically that remedies employed in folk medicine are indeed therapeutically active. In this second communication we report on antibacterial assays for 80 plant species conducted under simple laboratory conditions in a private clinic in Trujillo, Peru. The aim of the study was to scientifically test whether plants used in Traditional Medicine for the treatment of infections showed antibacterial activity. Extracts of samples of 80 species were screened for antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* using an agar-diffusion method. Two species tested as traditional water extracts and 35 species extracted in ethanol showed activity against at least one of the bacteria. To confirm the results of our first screening, a random sample of the initial species set was re-sampled, and the previous results could be confirmed.

Key words: Medicinal plant, antibacterial activity, northern Peru.

Resumen

Las infecciones bacterianas e inflamación se encuentran entre las enfermedades tratadas por curanderos tradicionales. La Organización Mundial de Salud se ha expresado como altamente interesada en la Medicina Tradicional, y es importante demostrar científicamente que los remedios usados en la medicina popular de veras son terapéuticamente activos. En esta segunda comunicación reportamos bio-ensayos de 80 especies de plantas llevados a cabo bajo condiciones de laboratorio sencillas en una clínica en Trujillo, Perú. la meta de este estudio fue de científicamente probar si plantas usadas en la Medicina Tradicional para tratar infecciones mostraron actividad antibacteriana. Extractos de muestras de 80 especies fueron revisadas para actividad antibacteriana contra *Staphylococcus aureus* y *Escherichia coli* usando un método de difusión en agar. Dos especies preparadas en extractos tradicionales con agua y 35 especies extraídas con Etanol mostraron actividad contra por lo menos una de estas bacterias. Para confirmar los resultados de la primera serie de ensayos, re-evaluamos un juego de especies al azar, y se confirmaron los resultados.

Palabras clave: Plantas medicinales, actividad antibacteriana, norte del Perú.

Introduction

Even though there is a global dominance to cure disease using Western medicine, in recent years, there has been an increasing economic importance and popularity for the use of Traditional Medicine (Revene *et al.*, 2008, Bussmann & Sharon, 2007). In some developing Latin American and Asian countries, the World Health Organization (WHO) reports that more than half of the population has used or continues to use Traditional Medicine as a primary form of healthcare (WHO, 1999). In most of these cases, the use of Traditional Medicine is often the most affordable and accessible route for the cure of disease. In some developed countries like the United States, however, there has also been an increasing use of traditional and complementary alternative medicine, even though Western medicine is readily available (Revene *et al.*, 2008; Bussmann & Sharon, 2007).

For thousands of years plants have been used in the practice of Peruvian Traditional Medicine or *curanderismo*. Specifically, northern-coastal Peru has been noted for being at the core of the "health axis" of the old Central Andean culture area (Camino, 1999) because of the diverse collection of medicinal plants that thrive in the northern regions. As a result, some national governments have sought to integrate Traditional Medicine as a vital component of healthcare and treatment (Revene *et al.*, 2008; Bussmann & Sharon, 2007).

Rich in fauna and plant diversity, Peru is becoming known as a location in which extensive ethnobotanical research is conducted, in an effort to preserve the unique properties of plants and to gain a deeper scientific understanding of how these plants can cure certain ailments (Neto *et al.*, 2002). One area of concentration is the study of the bacterial properties of certain plants, with certain plants being tested for antibacterial properties using bio-assays (Bussmann *et al.*, 2008). Most testing and studies have taken place in northeastern Peru, most notably in the Callejon de Huaylas (Neto *et al.*, 2002). However, few studies have been done in places like Trujillo or Chiclayo, to examine the bacterial properties of plants there. Defining the most serious bacterial infections in Northern Peru might help decipher whether

or not many plants have antibacterial properties (Villegas *et al.*, 1997, Bussmann *et al.*, 2007).

Materials and methods

Plant Material

Although a description of the methodology has been given previously (Bussmann *et al.*, 2008), we regard it as important to ensure that all readers have access to the material, and thus give an outline here again. Five hundred and twelve species of medicinal plants were collected in the Peruvian departments Lambayeque and La Libertad in the field, in markets of the coastal cities Trujillo and Chiclayo and around the homes and in gardens of traditional healers (*curanderos*) of the region. Fieldwork was conducted in August-September 2001, July-August 2002, July-August 2003, June-August 2004, July-August 2005, July-August 2006, June-August 2007 and June-August 2008.

Vouchers of all specimens were deposited at the Herbarium Truxillense (HUT, Universidad Nacional de Trujillo), and Herbario Antenor Orrego (HAO, Universidad Privada Antenor Orrego, Trujillo). Recognizing Peru's rights under the Convention on Biological Diversity, especially with regard to the conservation of genetic resources in the framework of a study treating medicinal plants, the identification of the plant material was conducted entirely in Peru. No plant material was exported in any form whatsoever.

The specimens were registered under the collection series "RBU/PL", "ISA", "GER", "JULS", "EHCHL", "VFCHL", "TRUBH", and "TRUVA-NERICA", depending on the year of fieldwork and collection location (Bussmann & Sharon, 2006).

The nomenclature of plant families, genera and species follows the Catalogue of the Flowering Plants and Gymnosperms of Peru (Brako & Zarucchi, 1993). Species were identified using the available volumes of Macbride (1936-1981), as well as other sources (Jørgensen & Ulloa, 1994; Pestalozzi, 1998; Ulloa & Jørgensen, 1993) and reference material in the herbaria HUT and HAO.

Ethnobotanical data were collected from plant venders while purchasing materials in local markets (mostly Mercado Mayorista and Mercado Hermelinda in Trujillo and Mercado Moshoqueque and Mercado Modelo in Chiclayo) and by accompanying local healers (*curanderos*) to the markets when they purchased plants for curing sessions and into the field when they were harvesting. In addition, plants were collected by project members in the field, and — together with the material purchased in the markets — taken to the homes of *curanderos* to discuss the plants' healing properties, applications, harvesting methodology, and origins (Alexiades, 1996). At the homes of *curanderos*, the authors also observed the preparation of remedies and participated in healing rituals. Plant uses were discussed in detail with informants, after seeking prior informed consent from each respondent.

From the complete plant inventory 80 species were selected for bioassays. Fifteen of the species represented a randomly selected subset of the plants tested previously (Bussmann *et al.*, 2008) in order to test the reliability of the methodology used. The selected plants encompassed the most often mentioned species used traditionally against infections (including infectious diseases, wounds, colds, bronchitis, kidney and urinary infections, post-partum infections etc.) as well as plants used against gastro-intestinal problems (especially diarrhea) because it was assumed that these plants would most likely show activity against the bacterial strains tested. In addition, other frequently used species were selected for random testing. Additional File 1 gives an overview on all species and their traditional uses.

Preparation of Extracts

Plant material was dried at 37°C for three days. After drying, the material was ground with a simple meat grinder. Fifty grams of plant material were submerged in 500ml of ethanol for seven days. To produce a traditional water extract for comparison, the plant material was boiled for five minutes and then left submerged for one day. After maceration, the alcohol extracts were filtered and the solvent was then evaporated using a hot water bath at 70°C. The resulting residue was used for bioassays. The water extracts were extracted and the

water was then evaporated using a hot water bath at 70°C. The dried extracts were re-suspended in 5ml distilled water. The antibacterial activity of the plants was determined by using an agar diffusion method.

Bacteria

Many laboratories in developing countries lack access to commercial grade bacterial strains. Demonstrating that simple techniques can be used for bioassays, bacterial samples obtained from patients treated at the clinic where testing was conducted were used for the assays. This approach has the additional benefit that plant material can be directly tested against bacterial strains prevalent in the local population. *Staphylococcus aureus* (Gram-positive) was isolated from a Laryngitis sample. Both patients were walk-ins and not hospitalized. Two lines of the Gram-negative species *Escherichia coli* were isolated from urinary tract infection samples. The bacteria were incubated on nutrient agar until clean lines could be cultivated. The identification of the bacteria followed (Barrow & Feltham, 1993). A direct classification of the strains was beyond the technical means of the laboratory. However, the isolates are kept in culture to allow reproduction of the results or further detailed analysis of the strains used.

Bioassays

The antibacterial activity of the crude plant extracts was determined using an agar-diffusion method (Koneman *et al.*, 1997). Bacterial strains were produced as described above. Bacterial cultures were grown on 5% sheep red blood agar (SBA) and then inoculated onto Mueller-Hinton Agar (PML) for testing.

Following the initial incubation, organisms were suspended in 10ml of distilled water and their concentration equilibrated to a 0.5 McFarland standard. Using a sterile cotton swab, each sample was transferred onto Mueller-Hinton Agar. Six mm lank paper disks were then saturated with 100µl of each plant extract, dried, and applied to the agar surface. Disks with Amikacin and distilled water were applied as controls. Amikacin was used because it was the only antibiotic available with efficacy against both *Escherichia coli* and

Staphylococcus aureus. Disks with distilled water (for water assays) and disks first saturated with Ethanol and then dried (for Ethanol assays) were used as negative controls. Plates were incubated overnight at 37°C. After 24h, zones of inhibition appearing around disks were measured and recorded in mm. At least three repetitions were run for each assay. The Amikacin control showed an inhibition zone of at least 7mm after 24h exposition in all assays tested. Plant species showing at least the same activity were considered anti-bacterially active.

Results and Discussion

Eighty plants were tested for antibacterial activity against two bacteria: *Escherichia coli* (gram negative) and *Staphylococcus aureus* (gram positive). Table 1 shows the ethnobotanical information for every species tested, Table 2 shows the results of the antibacterial assays. A larger number of plants showed antibacterial activity against *S. aureus* than against *E. coli*. Two of the plant extracts in water and 52 of the plant extracts in alcohol showed antibacterial activity, while 27 plants showed no antibacterial activity in water nor alcohol extracts.

For the plant extracts in water, Only *Bixa orellana* and *Ipomoea pauciflora* out of 80 plants extracted in water showed antibacterial activity (2.5 %), and only against *S. aureus*. *Bixa orellana* is commonly used to treat inflammation of the kidneys, prostate, bronchitis, hemorrhages, pulmonary system problems, urinary infections, and is also used for food coloring. Interestingly, the plant, had a larger ring in the water extract than in the alcohol extract. *Ipomoea pauciflora*, commonly known as huanarpo, is traditionally used to treat chills and colds.

Fifty-two out of the 80 plants (65%) extracted in alcohol showed antibacterial activity. Thirty-eight of the 52 plants were active solely against *S. aureus*, one plant was solely active against *E. coli*, and 13 plants were active against both (Table 2). Many species of this group, including *Arctium lappa*, *Citrus sinensis*, *Berberis buceronis*, *Hypericum silenoides*, *Mentha piperita*, *Syzygium jambos*, *Thalictrum decipiens*, and *Thymus*

vulgaris are traditionally used for the treatment of infections or illnesses that include gall bladder, diarrhea, urinary, intestine, liver, indigestion, colic, and gas problems are treated by a group of plants which include. Plants used to treat respiratory illnesses such as bronchitis, asthma, and cough include *Gallesia integrifolia*, *Malesherbia ardens*, *Prosopis pallida*, *Salvia sagittata*, *Stachys lanata*, and *Uncaria tomentosa*. Lastly, plants used to treat many different forms of cancer consist of *Psidium guajava* and *Smilax kunthii*.

Finally, plants that inhibited the growth of both bacteria included *Abuta grandifolia*, *Ambrosia peruviana*, *Capsicum chinense*, *Cestrum strigilatum*, *Cydista aequinoctialis*, *Krameria lappacea*, *Niphogeton dissecta*, *Senecio chionogeton*, *Smilax kunthii*, *Thalictrum decipiens*, *Uncaria tomentosa*, *Ximenia americana*, and *Iresine herbstii*.

The random subsample of species tested again did confirm that the testing methodology was sound. *Ambrosia peruviana*, *Cestrum strigilatum*, *Ephedra amaricana*, and *Tagetes erecta* showed very similar positive inhibition results to Bussmann *et al.* (2008), while *Pimpinella anisum*, *Cronquistantus lavandulaefolius*, *Capparis crotonoides* and *Sambucus peruviana* showed again negative results. A few species (*Acyrocline alata*, *Dipsacus jullonum*, *Plantago linearis*, *Psidium guayava* and *Uncaria tomentosa*) showed slight inhibition against *S. aureus*, while the same species had negative results previously, while *Rubus robustus*, which had previously shown a slight inhibition of *S. aureus* now tested negative (Bussmann *et al.*, 2008). This indicates that plants from a different location might also differ in their compound composition that can affect their efficacy, although in this case to a very minor extent.

Conclusions

The present study again confirms that simple laboratory methods are very well suited to assess the efficacy of traditionally used medicinal plants to inhibit bacterial growth. A comparison to the traditional uses also indicated that local knowledge can give important leads for the development of new treatments. Further

tests, especially with regard to toxicity, are needed to verify the safety of the traditional preparations.

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Table 1. Species encountered and used in Northern Peru

Family/Genus/Species	Indigenous name	Plant part use	Admin.	Use	Coll. #
ADIANTACEAE					
<i>Adiantum concinnum</i> Wild. ex H.B.K. TRUBH17 RBU/PL265, JULS149	Culantrillo del Pozo,	Leaves and Stems, Culantrillo	Oral fresh or dried	Blood purification, Hair loss, Menstrual regulation	V F C H L 2 9 ,
AMARANTHACEAE					
<i>Amaranthus hybridus</i> L.	Yuyo	Leaves and Stems, fresh	Oral	Inflammation (general)	GER190
<i>Iresine diffusa</i> H.B.K. ex Willd.	Paja Blanca, Sangrinaria	Whole plant, fresh	Oral	Liver, Kidneys, Inflammation of the ovaries, Blood, Menstruation symptoms in adolescents	JULS75, ISA62
<i>Iresine herbstii</i> Lindley	Colores, Timoras, Zangurache	Leaves, fresh	1. Topical 2. Oral	1., 2. Liver, Kidneys, Cancer of the blood, Blood circulation, Intoxication of the blood, Heart, Nervous system, Blood, Inflammation of the stomach, Inflammation	ISA42, EHCHL114, ISA121
ANNACARDIACEAE					
<i>Loxopterygium huasango</i> Spruce ex Engl.	Hualtaco	Wood, dried	Oral	Bone or muscular pain due to an accident, Pain from bone fractures	GER109
APIACEAE					
<i>Niphogeton dissecta</i> (Benth.) Macbr.	Homamo Toro, Orma Motora	1. Leaves and Stems, dried 2. Whole plant, fresh	1. Topical 2. Oral	1. Wounds (cancerous), Wounds from sorcery 2. Purgative	EHCHL166, RBU/PL338
<i>Petroselinum crispum</i> (Miller) A.W. Hill	Perejil	Whole plant, fresh	1. Oral 2., 3. Topical	1. Heart, Nervous system, High blood pressure, Infections, Nose bleeds, Food condiment, Forgetting love or trauma, Regulation of menstrual cycle 2. Daño, Fright / Susto 3. Infections, Nose bleeds, Food condiment, Forge tting love or trauma	ISA80, EHCHL31, ISA117, RBU/PL278, JULS225
<i>Pimpinella anisum</i> L.	Anis Criollo, Anís	Seeds, dried	Oral	Gases, Stomach Pain, Colic	EHCHL137, TRUBH21, GER213
APOCYNACEAE					
<i>Mandevilla antennacea</i> (A.DC.) Schum.	Bejuco Colambo Negro	Whole plant, fresh	Charm	Protecting the house and field	GER236
ARISTOLOCHIACEAE					
<i>Aristolochia ruiziana</i> (Klotzsch) Zahlbr.	Bejuca del Contraaire	Stems, dried	Oral	Untangling a person who is Ghavin trouble progressing in life, Untangling a person who is a mess	GER107
ASTERACEAE					
<i>Achyrocline alata</i> (H.B.K.) DC. TRUBH18,	Ishpinguillo, Ishpingo,	1., 2. Stems and Leaves, dried	1., 2. Topical	1. Fright / Susto, Daño in children, Arthritis,	ISA85, ISA109 J U L S 1 0 8 ,
<i>Ambrosia peruviana</i> Willd.	Flor de Ishpingo Altamisa, Marco, Artamisa, Manzanilla del Muerto, Marcos, Alta Misa, Ajenjo, Altamis, Llatama Negra Malera, Llatama Roja Malera	Leaves and Stems, fresh	1. Oral 2., 3. Topical	Bones 2. Arthritis, Bones 1. Heart, Nerves, Epilepsy, Liver, Bronchitis, Colds, Bad Air / Mal Aire, Burns 2. Fungus, Fright / Susto 3. After birth to reduce inflammation and prevent spasms in the woman's womb	RBU/PL370, TRUBH15, JULS90, GER9, GER110

<i>Arctium lappa</i> L.	Lampazo	Seeds, dried	Oral	Urinary problems, Skin, Liver, Gallbladder, Intestine, Tumors	GER227
<i>Baccharis latifolia</i> (R. & P.) Pers.	Chilca Chica, Chilca Grande	1. Leaves and Stems, fresh or dried 2. Leaves, fresh	1., 2. Topical	1., 2. Hot bones, Bone pain, Rheumatism, Arthritis	ISA86, ISA115
<i>Baccharis salicifolia</i> (R. & P.) Pers.	Hierba de la Plata, Chilco Hembra	Whole plant, fresh	1., 3. Topical 2. Seguro	1., 2. Good business, Protection, Good fortune, Good health 3. Allergies, Rashes, Pimples	TRUVan/Erica 5, GER125, GER 84
<i>Chuquiragua weberbaueri</i> Tovar	Amaro Amaro	Whole plant, fresh or dried	Oral	Cough, Bronchitis, Asthma, Liver, Air	JULS99, EHCHL131
<i>Clibadium cf. sylvestre</i> (Aubl.) Baill.	Flor de Novia	Flowers, Leaves and Stems, fresh or dried	Topical	Cold, Before marriage	EHCHL80
<i>Cronquistianthus lavandulifolius</i> DC.	Clavelillo, Espino de Hoja, Pulmonaria	Flowers, Leaves and Stems, fresh or dried	Oral	Cough, Bronchitis, Headache, Cold, Asthma, Pulmonary disease	ISA5, JULS233, GER163
<i>Cynara cardunculus</i> L.	Alcachofa	Stems and Leaves, fresh or dried	1., 2. Oral	1. Diabetes, Memory, Physical weariness, Liver, Blood purification, Mental weariness 2. Weight loss	VFCHL31, RBU/PL261, JULS94
<i>Senecio chionogeton</i> Wedd.	Hornamo Leon Amarillo	Leaves and Stems, fresh or dried	1., 2. Oral	1., 2. Bad Air / Mal Aire, Inflammation (general), Hallucinoen / Vision enhancement	GER60
<i>Senecio hypsandinus</i> Cuatr. <i>Tagetes erecta</i> L.	Omamo Blanco Flores del Muerto, Claveles Chino, Flor de Muerto	Whole plant, fresh Flowers and Leaves, fresh	Seguro 1. Topcial 2. Oral	Fragrance, Good Luck 1. Fright / Susto, Colic of the stomach, Bad Air / Mal Aire 2. Cough, Nerves, Inflammation (general)	RBU/PL358 EHCHL141, JULS156, GER112
BERBERIDACEAE					
<i>Berberis buceronis</i> J.F. Macbride	Palo Amarillo	Wood and Bark, dried	Oral	Liver, Hepatitis	JULS285
BIGNONIACEAE					
<i>Crescentia cujete</i> L.	Higueron	Latex from Leaf, fresh	Topical	Healing of belly button after birth	JULS164
<i>Cydistia aequinoctialis</i> (L.) Miers	Bejuco Amarillo	Flowers, Leaves and Stems, fresh	Topical	Daño, Internal inflammation from sorcery, Bruises froms sorcery	ISA6
BIXACEAE					
<i>Bixa orellana</i> L.	Achote, Hoja de Achote	Seeds and Leaves, fresh or dried	Oral	Inflammation of the kidneys, Prostate, Food coloring, Bronchitis, Hemorrhages, Pulmonary systems, Urinary infections	ISA126, RBU/PL264, JULS9, EHCHL20, ISA44, JULS293
BORAGINACEAE					
<i>Cordia alliodora</i> (R. & P.) Oken	Ajos Giro, Ajos Quiro, Ajo Sacha	Bark and Stems, dried	1. Topcial 2. Oral	1. Daño, Fright / Susto, Dispelling negative energy from the house 2. Bronchitis	ISA74, JULS281
BRASSICACEAE					
<i>Brassica oleracea</i> L. f. sp. <i>capitata</i>	Col, Repollo	Leaves, fresh	Oral	Gallbladder with stones	JULS147
BURSERACEAE					
<i>Bursera graveolens</i> (H.B.K.) Triana & Planchon	Palo Santo, Palo de Santo	Small Stems, Bark and Wood, dried	1. Topical 2. Oral 3. Incense	1. Daño, Fright / Susto, Sorcery 2. Cough, Flu, Bronchitis, Cold 3. Dispelling negative energy from the house, Bad shadow	ISA143, JULS210, GER34
CAMPANULACEAE					
<i>Centropogon articulatus</i> Drake	Conchalalay	Stems and Leaves, fresh or dried	Topical	Fright / Susto, Air / Aire	EHCHL119

CAPPARIDACEAE

<i>Capparis crotonoides</i> H.B.K.	Simuro, Bichayo, Simulo	1. Flowers, fresh 2., 3., 4. Leaves, fresh	1. Oral 2., 3., 4. Topical	1. Bronchitis 2. Arthritis, Rheumatism 3. Cold, General pain: muscular, bone, etc. 4. Bad Air / Mal Aire, Colds	GER4, JULS250
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CAPRIFOLIAEAE

<i>Sambucus nigra</i> L.	Cinta de novia	Stems, fresh	Charm	To tie a person	GER220
<i>Sambucus peruviana</i> H.B.K.	Sauco, Saucotillo	1. Leaves, Flowers and Stems, fresh or dried 2., 3. Leaves, fresh 4. Flowers and Leaves, fresh	1., 4. Oral 2., 3. Topical	1. Swelling, Kidneys, Cough, Concussions, Prostate, Fever, Bronchitis, Yellow Fever 2. Fright / Susto, Fever, Yellow Fever 3. Inflammation of the kidneys, Gastritis 4. Nerves, Cough, Cold, Fever, Insomnia	EHCHL140, RBU/PL291, VFCHL44, ISA131, ISA87, JULS246, EHCHL110

CHENOPODIACEAE

<i>Chenopodium quinoa</i> Willd. (wild form)	Quino Amargo	Seeds, fresh	Topical	Intestines (cleansing), Stomach (cleansing)	EHCHL160
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CLUSIACEAE

<i>Clusia minor</i> L.	Chusgon	Whole Fruit, fresh or dried	Oral	Nerves, Heart disease	JULS280
<i>Hypericum silenoides</i> Jus.	Cintaura	Whole plant, fresh	Oral	Diarrhea, Dysentery	EHCHL85

CONVOLVULACEAE

<i>Ipomoea pauciflora</i> M. Martens & Galeotti	Huanarpo	Whole plant, fresh	Oral	Chills, Colds	GER222
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CUCURBITACEAE

<i>Cucurbita maxima</i> Duch.	Zapallo	1. Flowers and joints of Stems, fresh or dried 2. Seeds, dried 3. Leaves, fresh	1., 2. Oral 3. Topical	1. Preventing miscarriage, Inflammation (general), Anxiety 2. Heart disease 3. Warts, Moles	JULS272, GER32
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DIPSACACEAE

<i>Dipsacus jallonium</i> L.	Cardo Santo	Whole plant, fresh	Oral	Diabetes, Liver, Cholesterol	EHCHL90
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EPHEDRACEAE

<i>Ephedra americana</i> H. & B.	Diego Lopez, Suelta con Suelta	Whole plant, fresh or dried	1. Oral 2. Topical	1., 2. Bruises, Fractures, Broken bones, External injuries	EHCHL150, JULS38, GER75
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EUPHORBIACEAE

<i>Acalypha mandonii</i> Muell.-Arg.	Chilca Dulce	Whole plant, fresh or dried	Oral	Liver Inflammation, Clean blood from toxins	RBU/PL294
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FABACEAE

<i>Dolichos lablab</i> L.	Frijol chileno	Fruits, fresh	Oral	Fever, Inflammation of the intestine, Protects the lungs	GER235
<i>Melilotus alba</i> Medikus	Alfalfilla	Seeds, dried	Oral	1. Gain weight 2. Fever, Tuberculosis, Colds, Infections internal, Respiratory infections	GER223
<i>Prosopis pallida</i> (H. & B. ex Willd.) H.B.K.	Algarrobo	1. Seeds, dried 2. Leaves and Stems, fresh 3., 4. Resin, fresh	1., 2. Oral 3., 4., 5. Topical	1. Cough, Anemia, Fertility, Sexual potency, Bronchitis, Nutritional Supplement 2. Stomachache, Hangover 3. Arthritis, Rheumatism, Colds, Bone ache 4. Toothache, Pull out tooth 5. Critical wounds	JULS97, GER8
<i>Senna bicapsularis</i> (L.) Roxburgh	Alcaparrilla, Alpacaquilla	Whole plant, fresh	Topical	Detoxification of alcohol and drugs, Detoxification of liver and kidneys	JULS95

KRAMERIACEAE

<i>Krameria lappacea</i> (Dombey) Berdet & B. Simpson	Ratania, Raima	Leaves and Root, fresh	Oral	Inflammation of the kidneys, Inflammation of the ovaries, Inflammation of the intestine, Internal Inflammation, Inflammation of the bladder	JULS53
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LAMIACEAE						
<i>Mentha x piperita</i> L.	Poleo	Whole plant, fresh or dried	Oral	Colic, Stomach Pain	JULS29	
<i>Salvia cuspidata</i> R. & P.	Salvia Blanca	Whole plant, fresh or dried	Topical	Fright / Susto, Daño	RBU/PL315	
<i>Salvia sagittata</i> R. & P.	Salvia Negra	Root and Stems, fresh or dried	Oral	Cough, Asthma, Hair loss	RBU/PL318	
<i>Stachys lanata</i> Jacq.	Veronica (Macho)	Whole plant, dried	Oral	Bronchitis, Asthma	JULS13	
<i>Thymus vulgaris</i> L.	Tomillo	Leaves, Stems and Flowers, fresh or dried	Oral	Cough, Colic, Liver, Gases, Indigestion, Bladder	EHCHL169	
LECYTIDACEAE						
<i>Gustavia augusta</i> L.	Chope	Leaves, fresh	Topical	Allergies, Rashes, Pimples, Hives	GER30	
MALESHERBIACEAE						
<i>Malesherbia ardens</i> Macbr.	Veronica	Whole plant, fresh or dried	Oral	Cold, Cough, Bronchitis, Asthma	EHCHL139	
MELASTOMATACEAE						
<i>Brachyotum tyrianthium</i> Macbride	Sarcilleja	Stems, fresh	Oral	Blood circulation	EHCHL55	
MENISPERMACEAE						
<i>Abuta grandiflora</i> (Mart.) Sand.	Abuta (male and female)	Root and Stems, fresh or dried	Oral	Contraceptive, Diabetes, Cholesterol	JULS88, RBU/PL312	
MYRTACEAE						
<i>Myrcianthes discolor</i> (H.B.K.) Vaughn	Lanche, Mirto	Whole plant, fresh	Oral	Food, Memory, Cerebral, Vitamins for the brain and for colds, Inflammation, Rheumatic pain, Stomach, Menstrual regulation	ISA34, EHCHL17, RBU/PL271	
<i>Psidium guajava</i> L.	Hoja de Guanábana, Graviola	Leaves and Stems, fresh or dried	Oral	Cancer, Liver sickness	VFCHL24	
<i>Scutia spicata</i> (H. & B. ex Schultes) Weberb. var. <i>spicata</i>	Pial, Pus	Stems, fresh or dried from the house	Cham	Keeping evil spirits away	JULS226	
<i>Syzygium jambos</i> (L.) Alston	Poma Rosa	Fruits and Leaves, fresh	Oral	Diarhea	GER173	
OLACACEAE						
<i>Ximenia americana</i> L.	Limoncillo	Whole plant, fresh or dried	Oral	Nerves, Stomach, Menstrual regulation	JULS184	
PHYTOLACCACEAE						
<i>Gallesia integrifolia</i> (Spreng.) Harms.	Palo de Ajo	Stems, dried	Oral	Bronchitis, Asthma	GER116	
PLANTAGINACEAE						
<i>Plantago linearis</i> H.B.K.	Llantén Serrano, Llantén de la Costa, Llantén	1., 2. Whole plant, fresh 3. Root, fresh	1. Topical 2., 3. Oral	1. Inflammation of wounds, Wounds (cleansing) 2. Liver, Inflammation of the kidneys, Wounds, Bladder 3. Cough, Bronchitis	JULS35, JULS86, GER133	
POACEAE						
<i>Hordeum vulgare</i> L.	Cebada	Seeds, dried	Oral	Inflammation of the kidneys, Inflammation (general)	JULS128, GER183	
POLEMONIACEAE						
<i>Cantua buxifolia</i> Jus. ex Lam.	Candu	Whole plant, fresh or dried	Topical	Fright / Susto, Speech impediment	JULS297	
RANUNCULACEAE						
<i>Thalictrum decipiens</i> Boivin	Chontilla (Chica)	Whole plant, dried	Topical	Fever, Papera in Children, Mumps	ISA15	
ROSACEAE						
<i>Prunus serotina</i> Ehrh.	Helialiso	Leaves, fresh or dried	Topical	1., 2. Arthritis, Fractures, Bone pain, Twists	EHCHL94	
<i>Prunus serotina</i> Ehrhart subsp. <i>capuli</i> (Cav.) McVough	Capuli	Whole plant, fresh	Topical	Wounds of the skin	JULS51	

<i>Rubus robustus</i> C. Presl.	Zarzamora, Moyaca, Zarza, Zarza Parrilla, Mora, Cushai	Flowers and Leaves, fresh or dried	1. Topical 2., 3., 4. Oral	1. Fright / Susto, Pain of the body 2. Diabetes, Cough, Cholesterol (high), Bronchitis 3. Throat (dried), Cannot speak 4. Kidneystones, Inflammation of the kidneys, Inflammation of uterus, Arthritis	EHCHL132(a), ISA41, ISA48, JULS47, EHCHL132(b)
RUBIACEAE					
<i>Uncaria tomentosa</i> (Willdenow ex Roemer & Schultes) DC.	Uña de Gato, Uncaria Tomentosa, Una de Gato de la Selva	Leaves and Stems, fresh or dried	Oral, Topical	Bronchitis, Kidneys, Asthma, AIDS, Allergies, Rheumatic infections, Cancer, Contraceptive, Ulcers, Prostate, Bladder, Arthritis, Bones, Blood circulation, Hemorrhages (internal), Wounds (internal), Kidney Inflammation	VFCHL11, RBU/ PL263, EHCHL103, JULS275, GER230
RUTACEAE					
<i>Citrus sinensis</i> (L.) Osbeck	Naranja	1. Flowers, fresh 2. Fruit, fresh 3. Fruit Peel, fresh	1., 2. Oral	1. Depression, Nerves, Insomnia, Anxiety 2. Laxative, especially for children 3. Stomach ache	JULS202, GER178
SMILACACEAE					
<i>Smilax kunthii</i> Killip & Morton	Palo de la China (Blanco)	Bark, Root and Stems, fresh	Oral	Cancer (all types)	ISA20
SOLANACEAE					
<i>Capsicum chinense</i> L.	Aji Panca	Fruit, fresh	Incense	Bad Air / Mal Aire	GER203
<i>Capsicum rhomboideum</i> (Dunal) Kunze	Aji Colorado	Whole Fruit, fresh	1. Charm 2. Topical	1., 2. Evil eye/ Mal ojo, Protecting the patient from envy	JULS91
<i>Cestrum strigilatum</i> R. & P.	Santa María	Flowers, leaves and Stems, fresh or dried	Oral	Control and regulate menstrual cycle	JULS245
<i>Lycopersicon hirsutum</i> Dunal	Ambulluco de Muerto	Whole plant, fresh or dried	Topical	Susto of Death/ Susto de muerte	ISA31
<i>Solanum tuberosum</i> L.	Chuno de Papa	Tuber, dried	Oral	After childbirth complications, Bronchitis, Respiratory problems	JULS140, JULS141
URTICACEAE					
<i>Urtica urens</i> L.	Ortiga	Stems and Leaves, fresh	1. Topical	1. Bad Air / Mal Aire, Prostate, Fright / Susto, Vaginal cleansing, Business, Casting away bad luck, Freight in children / Susto en niños	RBU/PL299,
VERBENACEAE					
<i>Lippia integrifolia</i> (Grieseb.) Hieron	Poleo del Inca	Leaves and Stems, fresh	Oral	Cold, Colic, Inflammation of the kidneys, Bronchitis, Rheumatism, Gases	EHCHL76

in BOLD: species also tested in 2007

Table 2. Screened plants showing antibacterial activity against at least one of the bacterial strains tested

Scientific name	Activity of water extract against <i>E. coli</i> *	Activity of water extract against <i>S. aureus</i> *	Activity of ethanol extract against <i>E. coli</i> *	Activity of ethanol extract against <i>S. aureus</i> *
<i>Abuta grandifolia</i> (Mart.) Sandwith			10 mm	12 mm
<i>Acalypha mandoni</i> Müll.-Arg.				11 mm
<i>Achyrocline alata</i> (Kunth.) DC.				10 mm (-)
<i>Amaranthus hybridus</i> L.				11 mm
<i>Ambrosia peruviana</i> Willd.			17 mm (-)	8 mm (12 mm)
<i>Arctium lappa</i> L.				15 mm
<i>Baccharis latifolia</i> Pers.				12 mm
<i>Baccharis salicifolia</i> (Ruiz. & Pav.) Pers.				10 mm
<i>Berberis buceronis</i> J.F. Macbr.				21 mm
<i>Bixa orellana</i> L.		22 mm		11 mm
<i>Brachyotum tyrianthum</i> Macbride				10 mm
<i>Brassica oleracea</i> L.				11 mm
<i>Capsicum chinense</i> Jacq.			9 mm	15 mm
<i>Capsicum rhomboideum</i> (Kunth) Kunze.				13 mm
<i>Centropogon articulatus</i> Drake**				6 mm
<i>Cestrum strigilatum</i> Ruiz. & Pav.		(12 mm)	13 mm (-)	15 mm (19 mm)
<i>Citrus sinensis</i> Osbeck				16 mm
<i>Clusia minor</i> L.				16 mm
<i>Crescentia cujete</i> L.			9 mm, 8 mm	
<i>Cydista aequinoctialis</i> Miers			7 mm	21 mm
<i>Cynara cardunculus</i> L.				14 mm
<i>Dipsacus jallorum</i> L.				12 mm (-)
<i>Ephedra americana</i> Endl.			(8 mm)	8 mm (22 mm)
<i>Gallesia integrifolia</i> (Spreng.) Harms				19 mm
<i>Hypericum silenoides</i> Juss.				13 mm
<i>Ipomoea pauciflora</i> M. Martens & Galeotti		10 mm		16 mm
<i>Iresine herbstii</i> Hook.			10 mm	16 mm
<i>Krameria lappacea</i> (Domb.) H.M. Burdet & B.B. Simpson**			12 mm	15 mm
<i>Lycopersicon hirsutum</i> Dunal				26 mm
<i>Malesherbia ardens</i> J.F. Macbr.				9 mm
<i>Mandevilla antennacea</i> K. Schum.				8 mm
<i>Mentha piperita</i> Stokes				6 mm
<i>Myrcianthes discolor</i> (Kunth.) McVaugh				16 mm
<i>Niphogeton dissecta</i> J.F. Macbr.			16 mm	10 mm
<i>Petroselinum crispum</i> (Miller) A.W. Hill.				15 mm
<i>Plantago linearis</i> Kunth.				10 mm (-)
<i>Prosopis pallida</i> (Humb. & Bonpl. ex Willd.) Kunth.				15 mm
<i>Prunus serotina</i> Ehrh.				12 mm
<i>Psidium guajava</i> L.				7 mm (-)
<i>Salvia cuspidata</i> Ruiz. & Pav.				18 mm
<i>Salvia sagittata</i> Ruiz. & Pav.				12 mm
<i>Sambucus nigra</i> L.				6 mm
<i>Senecio chionogeton</i> Wedd.			13 mm	18 mm
<i>Smilax kunthii</i> Killip & Morton			16 mm	18 mm
<i>Stachys lanata</i> Jacq.				12 mm
<i>Stevia</i> sp.				8 mm
<i>Syzygium jambos</i> (L.) Alston				13 mm
<i>Tagetes erecta</i> L.				12 mm (20 mm)
<i>Thalictrum decipiens</i> B. Boivin			12 mm	14 mm
<i>Thymus vulgaris</i> L.				16 mm
<i>Uncaria tomentosa</i> DC.			8 mm (-)	10 mm (-)
<i>Ximenia americana</i> L.			12 mm	10 mm

* The measurement of the zone of inhibition ring includes the measurement of the disks, which were 5 mm.
(in BOLD: species also tested in 2007: - = (negative))